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ABSTRACT

This student module on materials handling is one of 50 modules concerned with job safety and health. It presents the procedures for safe materials handling. Discussed are manual handling methods (lifting and carrying by hand) and mechanical lifting (lifting by powered trucks, cranes or conveyors). Following the introduction, 15 objectives (each keyed to a page in the text) the student is expected to accomplish are listed (e.g., Name four cause of wire rope deterioration). Then each objective is taught in detail, sometimes accompanied by illustrations. Learning activities are included. A list of references and answers to learning activities complete the module. (CT)

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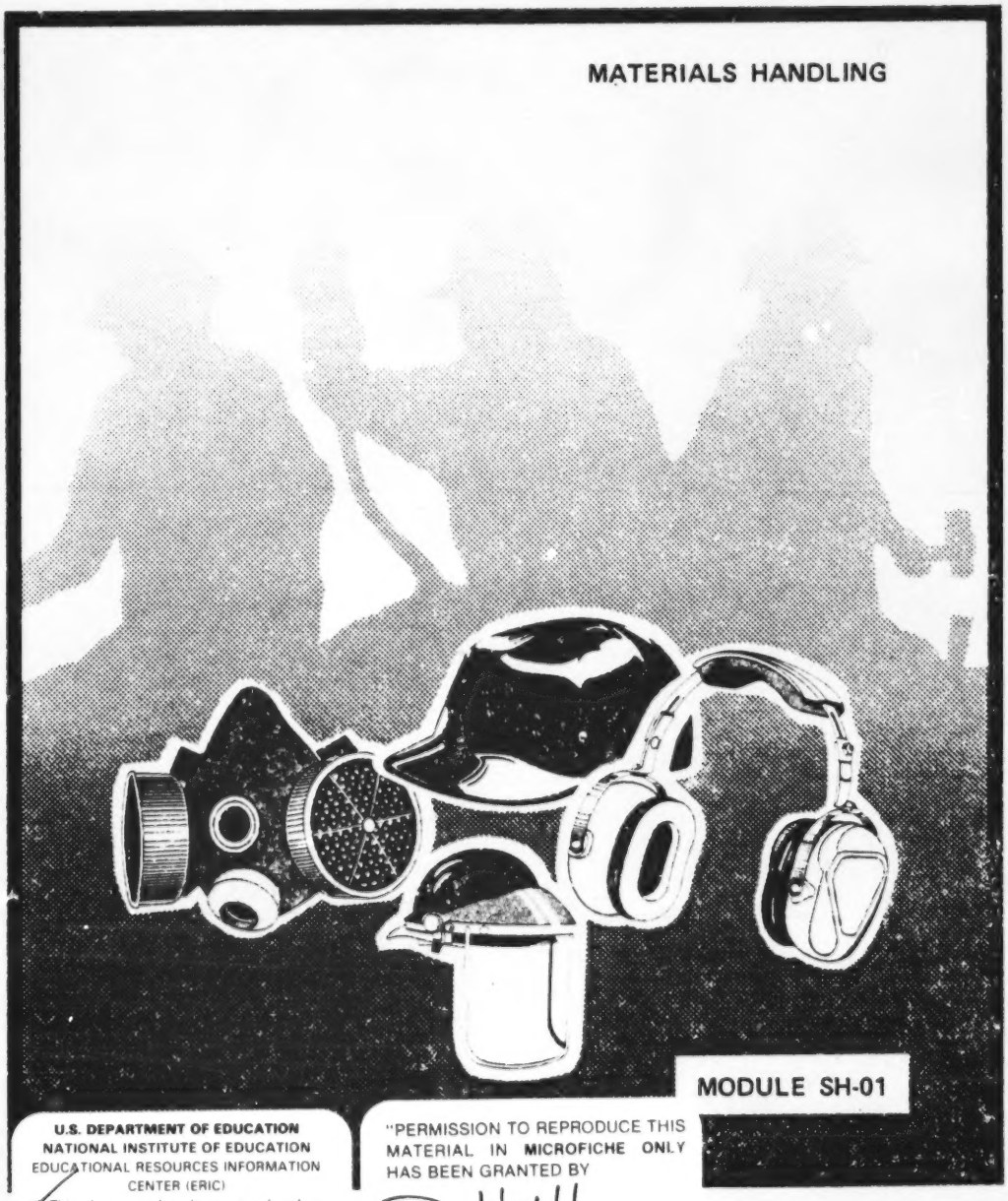
SAFETY AND HEALTH

MATERIALS HANDLING



MODULE SH-01

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INTRODUCTION

At some point in each day, most industrial workers have to handle materials. In the making of just one ton of finished products, about fifty tons of materials must be lifted, moved, stored, or otherwise handled.

Materials handling is best done mechanically (by power truck, cranes, conveyors, etc.), but often there is no mechanical way to do certain jobs, and the material must be moved by hand. Both methods — manual (by hand) and mechanical — have a high rate of accidents, resulting in injuries for workers and higher production costs for the employer. There were 2,200,000 on-the-job injuries in 1978, 13,000 of which were fatal. 80,000 resulted in some permanent injury. Twenty to twenty-five percent of these accidents were directly related to materials handling; most were the result of unsafe work practices that could have been avoided.

The best way to avoid injury is to plan the job ahead of time. Whenever possible, cut down on the number of times that material has to be handled. Consider the amount of weight and bulk to be moved, the route it has to travel, the condition of the floor surface, and the best possible mechanical aids for the job. Many accidents result from lifting, carrying, or handling objects with the wrong equipment or in the wrong way; others are caused by poor housekeeping or defective equipment.

This module presents the procedures necessary for safe materials handling. Manual handling methods (lifting and carrying by hand) and mechanical lifting (lifting by powered trucks, cranes or conveyors) are discussed.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. List six positions for feet, back, chin, arm, and body when preparing to lift materials. (Page 3)
2. Name five hand tools that aid in materials handling. (Page 6)
3. Name two safety devices that should be on a hand truck. (Page 8)
4. Name the correct position of the operator of a four-wheeled hand truck when moving down a slope. (Page 10)

5. Name two reasons why powered hand trucks are more hazardous than nonpowered hand trucks. (Page 11)
6. Name four items that would be included in an examination to certify an operator of a powered industrial truck. (Page 12)
7. Name two types of power sources for industrial powered trucks and two hazards of each. (Page 12)
8. Given a list of correct and incorrect driving rules, identify those rules that correctly apply to driving powered industrial trucks. (Page 14)
9. State the reason for using a dock plate. (Page 17)
10. Name two procedures that must be associated with loading or unloading a highway truck. (Page 17)
11. State four procedures that must be followed while loading or unloading a railroad car. (Page 18)
12. Name two hazards workers must avoid when working around a conveyor. (Page 19)
13. Name four causes of wire rope deterioration. (Page 21)
14. Name three kinds of damage that should be checked for during a chain sling inspection. (Page 24)
15. Name three precautions that must be taken to prevent a rope, load attachment, or mechanism of a crane from breaking, releasing a load in mid-air, and injuring a worker. (Page 26)

OBJECTIVE 1: List the six positions for feet, chin, back, arms, and body when preparing to lift materials.

Lifting, carrying, or setting down materials the wrong way causes about half of all materials handling accidents. Many workers sprain or strain their backs while lifting loads too heavy for them. Because some workers can carry or lift much more than others, it is impossible to set limits on how much a worker should lift. Workers should tackle only the jobs they know they can handle.

Even when a worker can handle a load, injuries such as scrapes, cuts, and bruises can occur if not enough room has been provided for feet, hands, and the load. Other injuries can occur when a rough or uneven floor causes the worker to trip or slip, or when objects with points or sharp edges cut or puncture hands.

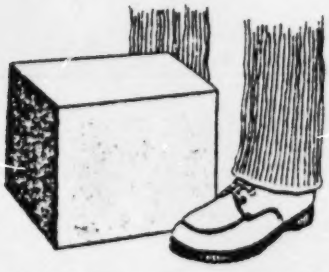
Before a worker picks up a load, he or she should always:

- Clear a path to the place where the material is to be taken, and be aware of clearances (room for the material and parts of the body to pass).
- Check floor for rough spots or unevenness.
- Inspect hands to be sure they are dry and free of oil and grease before the lifting process begins.
- Wear safety shoes and gloves when possible.
- Inspect materials for jagged edges, slivers, and splinters before lifting.
- Keep fingers away from "pinch points," especially when setting down an object.
- Lift gradually and without twisting to avoid strain.

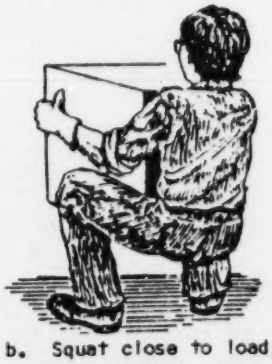
In most materials handling accidents, the materials are not the cause, the worker is. The worker tries to lift a load that is too heavy, to carry a load too far, or to handle material that is too large, and so he or she suffers a sprain or other serious injury. There is a right way and a wrong way to lift. The right way is to keep the back straight, using the strength in the arms and legs to do the lift. This method will reduce the amount of stress put on the back, the part of the body most likely to be hurt when lifting, carrying, and setting down objects.

HOW TO LIFT CORRECTLY

Shown in Figure 1 are the proper ways to lift and set down large, heavy loads that require the use of both hands. Feet should be apart, with one foot beside the object and the other immediately behind it (Figure 1a). The rear foot will provide the main force, or thrust, of the lift. Your back should be straight as you "sit down" to take up the load (Figure 1b). A straight back is not always a vertical back. The back may be bent forward from the hips as long as the spine is held fairly rigid. Grasp the load at diagonally opposite corners (Figure 1c). Use your whole hand, not just the fingers. Tuck in your chin (Figure 1d); this will help keep your back straight as the lift begins. Breathing in is also helpful. Hold arms and elbows close to the body. Your body weight should be centered over your feet (Figure 1e).



a. Position feet near load; one foot beside the load, the other behind it.



b. Squat close to load, keeping back straight.

c. Grasp load at diagonally opposite corners, using whole hand.

d. Tuck in chin, and breathe in.

e. Lift with legs; keep back straight.

f. Do not jerk or twist and keep load close to body.

Figure 1. Proper way to lift.

Once you are balanced over the load and you have grasped the object firmly, begin the lift with a thrust of the rear foot. The actual lifting should be done with the legs.

The body should never be twisted while under the strain of lifting or setting (Figure 1f). The load should be set down the same way it was picked up, with the worker's body straight and the strength coming from the arms and legs.

Because of their size and shape, some materials should be handled differently. For example, bulk loads such as boxes, cartons, or sacks are best carried on a shoulder. Carrying loads at chest or waist level puts too much strain on the back because of the added pull of the weight in front. When lifting a box or carton, hold alternate top and bottom corners, drawing a corner of the box between the legs. Materials in sacks can be lifted off the ground in much the same way. But the sack should be held for a moment at hip level before it is swung over one shoulder. Sacked material should be carried resting on its side, with the worker's free hand balancing the front corner of the shouldered sack.

Figure 2. A lifter bar, or drum lifter.

Barrels, drums, and cylinders usually require two people for safe handling. The objects should be rolled on their sides, if this can be done without spilling the contents or losing control of the load on slopes. When a drum must be moved by one person, a lifter bar (see Figure 2), or commercial barrel or drum lifter, should be used. The lifter bar is hooked over the rim of the barrel and gripped to control the direction of the roll. A barrel or drum should never be kicked to change its speed, but should always be moved slowly to keep the weight under control.

To prevent injury to the worker, sharp objects, such as sheet metal and glass, must be handled with heavy, leather gloves and moved in service trucks similar to the one shown in Figure 3.

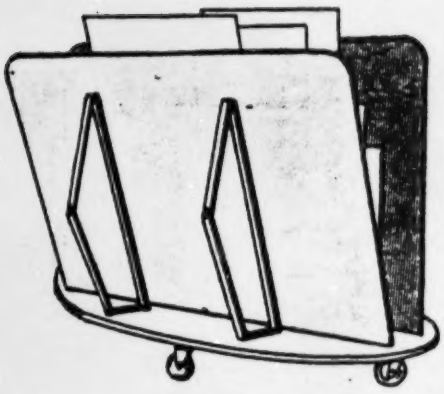


Figure 3. Service truck for transporting materials such as glass or sheet metal.

Because of their size and shape, some materials as they are being carried could injure other workers. Long ladders, boards, or pipes are difficult to control and may hit other workers or equipment. These objects should be carried over the shoulder with the front end high. Red flags should be tied to the ends of long objects to warn other workers. It is also a good idea to pad the ends of long objects so that if someone is hit, the injury won't be as bad. The safest way to transport long objects is to put one worker ahead of the object and one behind to warn others as the load is moved.

ACTIVITY 1:*

List six positions for feet, chin, back, and body when preparing to lift.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

OBJECTIVE 2: Name five hand tools that aid in materials handling.

There are hand tools, such as bars, hooks, rollers, jacks, (shown in Figure 4), and shovels, which help in the manual lifting, carrying, and setting of materials. These tools speed up materials handling by making it

*Answers to activities appear on page 30.

easier to grip and hold them, as well as by increasing lifting power. Like other tools, these must be used properly to avoid injury.

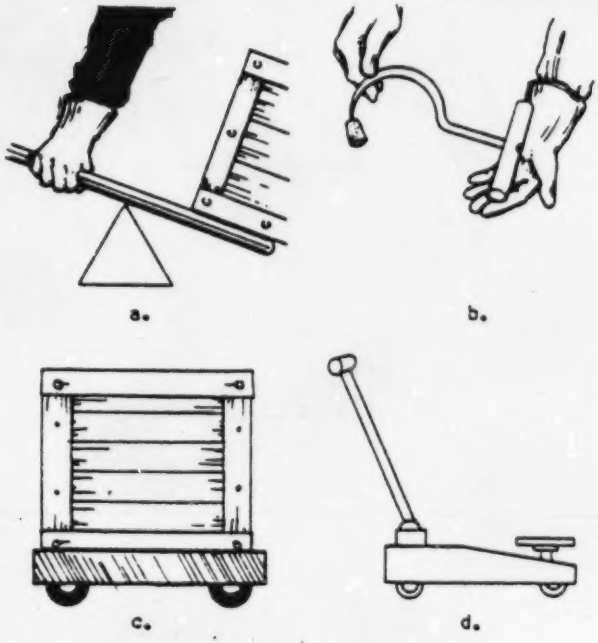


Figure 4. Hand tools that aid in mechanical lifting.

Bars (Figure 4a) that can be used as lifting aids come in various kinds and sizes. The kind and size best for the job should always be used. Certain safety precautions must be followed when using bars. First, the bar should be checked for cracks or weak points before use. Second, because a bar can slip, a worker should never work astride it or use it with greasy or slippery hands. Always avoid pinch points where the load and the bar meet.

Hand hooks (Figure 4b) are useful in lifting but also can be hazards in the workplace if not used properly. Dull hooks can slip unexpectedly. They must be sharp so they will not slip off the object and hurt the worker or damage the material being lifted. Hook handles must be free of splinters, and if the hook is carried on the belt, the point should be protected. Workers should be trained in the use of hand hooks.

Rollers (Figure 4c) should be used to move heavy, bulky objects. A bar is helpful in changing the direction of materials being moved on rollers. Be very careful when choosing a makeshift roller. A compressed gas cylinder should NEVER be used as a roller. A damaged cylinder could become a deadly jet-propelled missile as the gas escapes. Keep feet clear of rollers to avoid crushed toes.

Jacks (Figure 4d) and shovels are also used in materials handling. Jacks should be marked with their load limit and must not be used for more than their top load. They must be placed on a firm, level surface. If they are placed on "earth," hardwood blocking — both at the load and under the jack

base — is needed to prevent shifting or sinking. To avoid injury to the worker, jack handles must be removed when the jack is not in use.

Personal protective equipment, such as safety shoes, removable toe, instep, and shin guards, should be worn to protect the worker from injury if the load slips or moves suddenly.

When using shovels, workers must beware of splintered handles that could cause hand injuries. Shoes with good soles should be worn to protect the foot. Force should be applied to the shovel with the ball of the foot, not the arch.

ACTIVITY 2:

Name five hand tools that aid in materials handling, and one danger in using each.

1. _____
2. _____
3. _____
4. _____
5. _____

OBJECTIVE 3: Name two safety devices that should be on a hand truck.

Two-wheeled hand trucks, such as dollies and wheelbarrows, are used to carry loads from one place to another on the job. They seem to be easy to handle but can be tricky, and need to be used carefully.

Accidents with hand trucks occur when the truck is pushed off dock plates or platforms, when it hits something, or when the worker's hands are jammed against door frames or other obstacles. Many of these accidents can be avoided if hand trucks have knuckle guards to protect the hands and fingers, and brakes so the worker does not have to use his or her feet to stop the truck. A hand truck with knuckle guards and brakes is shown in Figure 5. Some two-wheeled trucks have hand brakes to give the operator easier control (Figure 6). Trucks not loaded properly may cause accidents, so the load must be centered on the vehicle. It should not project over the front or sides

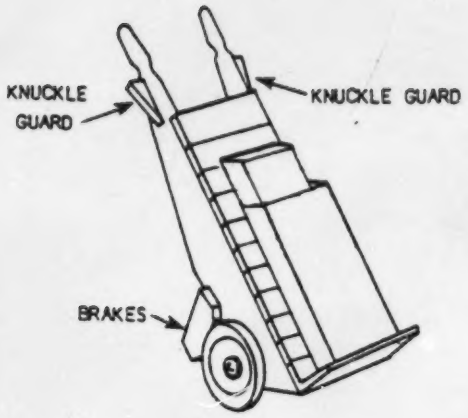


Figure 5. Hand truck with knuckle guards and brakes.

Figure 6. Two-wheeled truck with hand brake, being pushed down slope of dock plate.

where it might hit people or things as the truck is moved. Also the load should not be so high or wide that the operator cannot see where he or she is going. It is important to balance as much of the load as possible on the axle, allowing the truck to do most of the work. To keep a low center of gravity, lighter objects should be stacked on top of heavier items. When carrying bulky or pressurized items (such as gas cylinders), strap or chain the item to the truck.

ACTIVITY 3:

Name three possible dangers in using a hand truck:

1. _____
2. _____
3. _____

and two safety devices which can help prevent them:

1. _____
2. _____

OBJECTIVE 4: Name the correct position of the operator of a four-wheeled hand truck when moving down a slope.

Not all hand trucks are two-wheeled, as the ones shown in Figures 5 and 6; some have four wheels, as the dolly truck shown in Figure 7. Most four-wheeled, hand-operated trucks can be either pulled or pushed. When guiding a truck down a ramp or slope, the worker should be behind the truck to avoid being run down if the truck should happen to get out of control. When going up a slope, the worker should be uphill from the truck facing the way he or she is going.

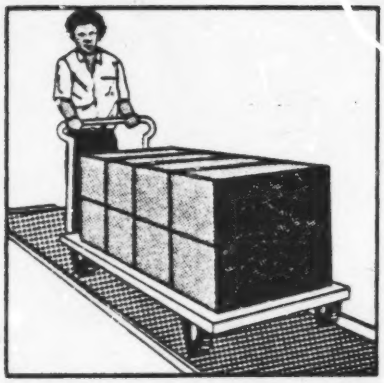


Figure 7. Four-wheeled hand truck.

To have a clear view of the aisle or walkway, the worker should never walk backwards when pulling a load. Many workers have been pinned beneath a load while pulling a hand truck backwards.

When using a hand truck, watch for floor hazards such as holes around docks, platforms, or raised runways that could cause the hand truck to tip, spilling the contents on workers below.

When not in use, hand trucks should be parked in a special area where they will not cause people to trip or stop the flow of traffic. A truck with a handle should be parked with the handle placed so that no one will bump into it.

ACTIVITY 4:

Name the correct position of the operator of a four-wheeled hand truck when moving up and down a slope.

_____

_____

OBJECTIVE 5: Name two reasons why powered hand trucks are more hazardous than nonpowered hand trucks.

Some industrial hand trucks have power units that help move the load. These trucks present many hazards because they move faster and are harder to stop than hand trucks.

Accidents often occur when the operator is caught between the truck and another object, or when a powered hand truck collides with another object. It is important that the operator know the capabilities and limits of the equipment. All powered hand truck operators must be thoroughly trained and authorized to use the trucks.

Rules for operating powered hand trucks include:

- Always operate with dry hands; grease, oil, or dampness can cause slips and accidents.
- Normally, operators should stand to the right or left of the handle and face the direction of travel. One hand must be kept on the handle at all times. In small areas such as elevators, it may be necessary for the operator to push the hand truck from behind.
- Pedestrians have the right-of-way.
- Do not go faster than a normal walking pace.
- Beware of collisions, and stop at blind corners, doorways, and intersections.
- Never allow anyone to ride the truck or use it as a toy.
- Hazardous materials should be carried in special containers.

Most powered hand trucks have safety devices, such as knuckle guards, wheel covers, and a flashing beacon light. These trucks should always be operated at reasonable speed, considering load size, clearance, visibility (how well the operator can see ahead), and traffic in the area.

ACTIVITY 5:

Name two reasons why powered hand trucks are more hazardous than nonpowered hand trucks.

1. _____
2. _____

OBJECTIVE 6: Name four items that would be included in an examination to certify an operator of a powered industrial truck.

A powered industrial truck, such as a forklift truck, is a large and powerful vehicle which is ridden by its operator and can cause serious injury and property damage if it is not used correctly. OSHA requires that operators be trained, get a license, and be certified. Training should include classroom work and supervised operation. Students must learn to master an obstacle course made of pallets, aisles, materials, and obstacles that might be found in the normal workplace. To be certified, a student would also be tested on backing up the truck, inspecting vehicles, and how to place forks when loading and carrying materials.

ACTIVITY 6:

Name four items that would be included in an examination to certify an operator of a powered industrial truck.

1. _____
2. _____
3. _____
4. _____

OBJECTIVE 7: Name two types of power sources for industrial trucks and two hazards of each.

Powered industrial trucks have either electrically-powered or fuel-powered motors (gasoline, diesel, or liquefied-petroleum gas). Each type is made for use in certain places. For example, an EX type is an electrically-powered industrial truck that may be used in places where flammable gases occur or hazardous amounts of harmful dusts, such as metal dust, aluminum, magnesium, carbon black, coal, or coke dust are present. Such trucks have a label showing where they are to be used.

When using electrically-powered industrial trucks, workers should exercise care in handling the battery charger and keep it away from contact

with battery acid and the flammable (easy to set afire) hydrogen gas given off by the batteries. When handling storage batteries for electrically-powered trucks, workers should protect themselves from acid burns by wearing chemical goggles, rubber gloves, aprons, and rubber boots. Only trained personnel should change or charge batteries. Where battery charging is taking place, there should be fire protection, adequate air flow to draw away flammable gases, places to flush eyes to neutralize acids, and a way to protect charging equipment from trucks and other vehicles. Open flames or sparks in battery-charging areas must be prevented. Smoking is never allowed in the area.

The main hazards in filling gas tanks are possible fire and explosion. So diesel- and gasoline-powered trucks should be refueled in open air places, away from main buildings. Filling hoses and fuel equipment must be electrically grounded and the truck motor off before refueling. Smoking is never allowed in refueling areas.

Diesel- and gasoline-powered trucks have internal combustion engines that must be specially equipped with spark suppressors to prevent them from lighting fires or causing explosions. For example, if a truck is being operated in an area where gasoline fumes are present, sparks from the engine or exhaust could easily start a fire or explosion. Spark suppression will prevent this type of accident.

Industrial trucks using liquefied-petroleum gas (LPG) normally produce less carbon monoxide than vehicles using gasoline. But liquid-petroleum units can easily catch on fire if their fittings or connections leak. To prevent gas release, fittings must be installed correctly and should be certified by a recognized testing agency. Connections must be tightened before refueling begins. (The operator must carry a small squeeze bottle filled with detergent and water. Soapy water, when applied to the connection, will expose gas leakage.)

ACTIVITY 7:

Name two types of power sources for industrial trucks and two hazards of each type.

1. _____
2. _____

OBJECTIVE 8: Given a list of correct and incorrect driving rules, identify those rules that correctly apply to driving powered industrial trucks.

There are two points that make driving a powered industrial truck different from driving a car. First, a powered industrial truck is guided by its rear wheels, which makes the truck easier to steer when it is carrying a load. Second, a powered industrial truck is driven in reverse as often as it is driven in forward gear. Besides these factors, the driver of a powered industrial truck must travel in irregular traffic situations, around various materials, over different types of surfaces, and so forth. For these reasons, only trained and authorized personnel should operate a powered industrial truck.

No industrial truck should ever be used for any job except the one for which it was designed — hauling, pulling, lifting, stacking, or excavating.

Most accidents involving powered industrial trucks can be prevented by (1) using safely built and properly maintained vehicles and (2) maintaining safe operating conditions.

Potential operators of a powered industrial truck should have a physical examination to see that their vision, hearing, muscle coordination, and reaction time is good. Drivers should also be tested to make sure that they are emotionally and mentally able to operate such a vehicle.

Safe driving rules must be followed by the operator of a truck; all traffic rules must be followed, and speed limits are not to go above six miles per hour. The operator must always drive slowly enough to make a turn without danger of tipping over and to stop in time if someone steps in the truck's path. When a truck is parked, the operator must put the controls in neutral, turn off the power, set the brakes, and remove the keys to prevent an untrained worker from trying to drive the vehicle.

Two items that must be on every powered material handling vehicle are the nameplate showing the weight of the truck and maximum load to be carried, and a fire extinguisher. Trucks may also carry a warning device, such as a horn, that is loud enough to be heard above the surrounding noise.

Figure 8. Industrial truck with platform.

Industrial trucks with platforms which are used for lifting materials (shown in Figure 8) can present serious hazards if not operated within speed limits and on good floor surfaces. Uneven, rough, pitted, or unstable floors can cause the truck to tip over. Overloading is a main cause of tip-overs. All loads must be neatly piled and, if possible, cross-tied to prevent material from slipping. The load must be carried low enough to prevent striking anything overhead, but high enough to avoid raised or uneven surfaces. Loads should never be raised or lowered while the truck is moving, because a moment of inattention could result in a collision.

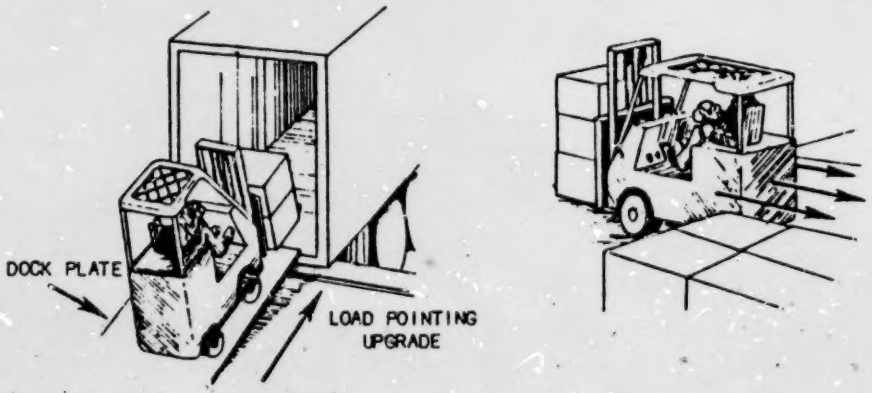
A lift truck should be used to lift a worker only if a safety platform with guardrails or a bucket is secured to the forks to keep the worker from falling. Also, the worker on the platform must have some way of shutting off the power to the truck, to avoid getting caught between the platform and some obstruction.

Workers should never stand or pass under the lift portion of any truck, whether it is loaded or empty. If the lift or the load dropped, it could injure or kill the person below. When a lift truck is parked, the lift should be placed in the lowest position to prevent people from walking under it.

Other rules for powered industrial trucks are listed here:

- If loads are carried above head level, the truck should have an overhead guard that does not interfere with vision.
- Gears, belts, and tires must have structural guards.
- A distance of at least three truck lengths should be kept between vehicles.
- Passing is not allowed unless the way is absolutely clear, and operators should slow and honk at corners and intersections.
- Operators should place the forks under the load as far as possible, and never tilt the load forward unless it is in a position to put the load down.

- Forks should be tilted down to pick up round objects and spread wide to hold boxed loads more securely.
- Forks should be slightly raised, even if there is no load on the truck, to make smooth traveling easier.
- Unstable loads are not to be carried.
- Items should be loaded with most of their weight as low as possible.
- Grades should be traveled up or down slowly with the load carried upgrade.
- Driving with the load pointing upgrade (Figure 9a) allows greater control. (Whenever vision is blocked by large loads, driving in reverse is recommended [Figure 9b].)
- Operators must never park in unauthorized or congested areas.



a. Driving upgrade

b. Backing with load

Figure 9. Driving powered truck with a load.

ACTIVITY 8:

(Write "correct" or "incorrect" in the blank.)

_____ 1. Plant speed limits should not exceed six miles an hour.

_____ 2. When load blocks front view, operator should lean out of cab to see around load and travel forward.

_____ 3. Operators should slow down and honk at intersections.

_____ 4. Drive with the load pointed downgrade for greater control.

_____ 5. Drivers should remove the keys from the parked truck.

OBJECTIVE 9: State the reason for using a dock plate.

Dock plates (also called dockboards or bridge plates) are used to provide a smooth, gapless riding surface between a vehicle and dock. They must always be fastened firmly to prevent slipping or "walking" during use. They must also be heavy enough to bear the weight of lift trucks and their loads. The sides of dock plates should be turned up to help keep vehicles from falling off, and the ends should be turned down to allow easier access. Dock plates must be protected from the elements — especially snow and ice — and should be covered with canopies when not in use.

To use a dock plate, the worker must slide it into place, taking care not to drop it. Large plates should be placed by a powered truck. If the dock plate is put in place by hand, hand holds must be provided. The wheels of vehicles to which the plates are attached must have chocks put in front of them to prevent movement when powered trucks are run onto the docks for loading or unloading.

ACTIVITY 9:

State the reason for using a dock plate and two steps you can take to avoid accidents while using one.

_____

_____

_____

OBJECTIVE 10: Name two procedures that must be done before loading or unloading a highway truck.

Before loading or unloading highway trucks, the brakes must be set and wheels blocked with chocks (see Figure 10) placed under both rear wheels. When semitrailers are not attached to cabs, they should be held up by a fixed jack to prevent the semi from tipping when the lift truck enters the trailer. This is most important when unloading the last section of the load from the far end of the trailer. Jacks should be placed on either side of the nose

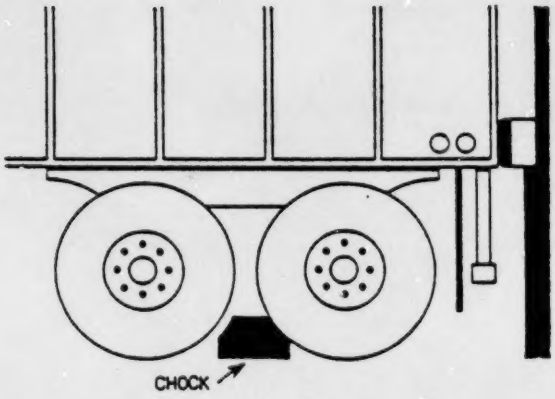


Figure 10. Wheels must be chocked before trucks are unloaded.

to support the landing gear assembly. Many accidents can be avoided by following these rules:

- Always follow the bulk and weight limits of the truck as posted on the nameplate of the vehicle.
- To prevent load shifts, secure the load with blocks, lashes, ropes, or chains.
- Keep hands and arms within guarded areas.
- Do not move the truck until the driver and crew (if any) are safely situated and clear of possible load shifts. All other workers should leave the truck and allow it ample room to leave the area.
- A red flag (or lamp at night) should be fastened to the rear end of vehicles carrying loads that go beyond the tailgate.
- When working on flatbed trucks, workers should stay away from the edges of the bed — especially in wet or slippery conditions.

ACTIVITY 10:

Name two procedures that must be done before loading or unloading a highway truck.

1. _____
2. _____

OBJECTIVE 11: State four procedures that must be followed while loading or unloading a railroad car.

To safely unload a railroad car, the worker must use a dock plate that is wide enough for trucks to enter at a safe angle — sometimes plates need to be wider at the dock side. The dock plates must be fixed securely (see section on dock plates). Rail cars to be loaded or unloaded must be marked by flags or lights so they will not be moved by switching crews. No other car or engine should be coupled to a car while it is being unloaded. After the rail car has been loaded or unloaded and before it is moved, workers

should be clear of the track; dock plates and platforms should be removed and all moving equipment (hooks, cables) must be out of the rail cars.

ACTIVITY 11:

List four procedures that must be followed to safely load or unload a rail car before it is moved.

1. _____
2. _____
3. _____
4. _____

OBJECTIVE 12: Name two hazards workers must avoid when working around a conveyor.

Conveyors are used to move large amounts of bulk materials from one point to another. Some conveyors are power driven while others are moved by hand pushing or by gravity.

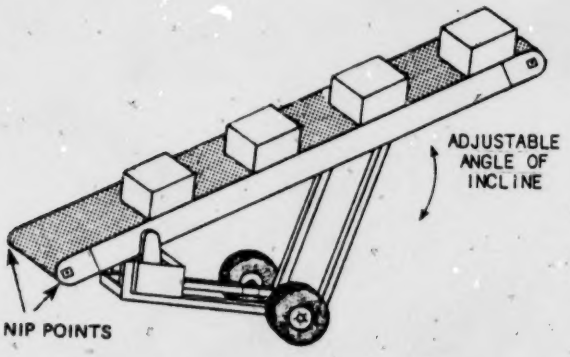


Figure 11. Powered portable belt conveyor.

One type of conveyor widely used in industry is the powered, portable belt conveyor, shown in Figure 11. This conveyor is set at an angle that can be altered for warehouse work and for truck and aircraft loading.

Bulk materials such as coal, gravel, sand, and stone can be moved at high speeds on a vibrating conveyor, such as the one illustrated in Figure 12. As the conveyor is mechanically vibrated, the materials are moved — or shaken — along from one level to another level. The rate at which the materials move is controlled by the amount of conveyor vibration.

The overhead conveyor, shown in Figure 13, is commonly used in foundries or in painting areas of other plants, such as automotive plants. Two hazards

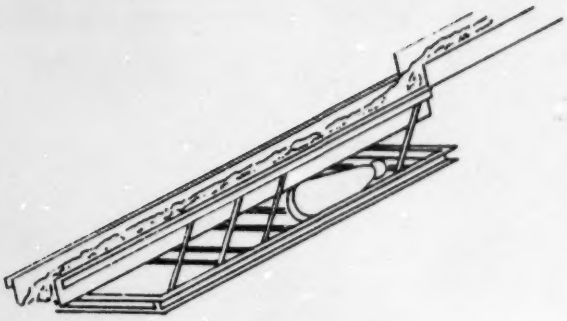


Figure 12. Vibrating conveyor.

that workers must avoid when working around a conveyor are (1) getting caught in the nip point where the belt runs onto the roller and (2) getting caught in a piece of material on the conveyor, and in that way being forced to move with the conveyor.

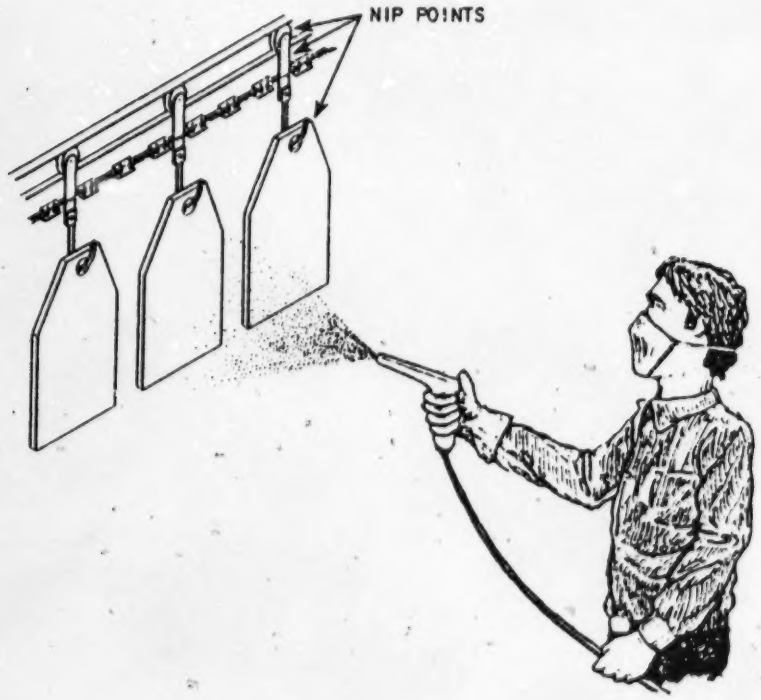


Figure 13. Overhead conveyor.

For safety during operation, the following steps should be taken:

- Never allow anyone to ride on conveyors.
- Conveyors must be shut off and locked out (locking out means placing a lock on the power switch so that no one can turn power back on without a key) before inspections or repairs are made.

- Jamming should be corrected from the top of the chute, if possible. Workers in the chute must wear life lines and have someone outside the chute to assist with emergencies.
- Where conveyors pass over work areas, the conveyors should be guarded to keep material from falling off and hitting workers.
- Conveyors should stop automatically when the units have been filled.
- The operator should be able to work the starter switch while in view of the conveyor.
- Workers must stay away from edges of loading docks.
- Materials should be loaded or unloaded only at proper points of the conveyor.
- Emergency stop devices should be placed no more than 40 feet apart along the conveyor line (if the conveyor passes through floors or walls, stop devices should be placed in each work area).
- Electrical conveyors should be made so that the load will descend at a controlled speed if power is suddenly interrupted during use.
- Loading and discharge points should be covered with exhaust hoods if the conveyor is moving fine or powdered material.
- Workers near conveyors should wear safety shoes, close-fitting attire, and dust goggles or respirators if the area or load is dusty.

ACTIVITY 12:

Name three types of conveyor.

1. _____
2. _____
3. _____

List two dangers to be avoided when working near a conveyor.

1. _____
2. _____

OBJECTIVE 13: Name four classes of wire rope deterioration.

There are two kinds of rope: fiber and wire. Fiber rope is generally used for temporary jobs, such as construction or painting or marine operations. Wire rope or steel cable is used in permanent installations or where very heavy loads must be lifted.

Before a fiber rope is used, the outside of the rope should be inspected carefully. Rope that is dry or brittle is unsafe for use and must be thrown away to prevent another worker from using it.

Acids, caustics, or their gases will cause a fiber rope to become weak. Scratching the fibers of a rope is one way to test for chemical damage. If the fibers come apart easily when scratched, the rope has suffered chemical damage. A rope that is discolored may also have chemical damage, but not every rope that is chemically damaged will show a color change. Because of this, it is a safe practice to discard any fiber rope that has been exposed to acid or other corrosive chemicals.

The inside of a rope should also be checked before use. This is done by twisting the strands of the rope: the inside must be as clean as when the rope was new. A rope that is dirty on the inside has been weakened and should never be used for hoisting.

Other signs that a rope is unsafe for use are (1) broken fibers inside (this condition shows the rope has been overloaded), (2) the heart of a four-strand rope pulls out easily in short pieces, and (3) the inside of the rope contains a build-up of powder-like sawdust which means too much internal wear as the rope was flexed back and forth in use.

Proper storage of ropes is important to keep them safe for use. Ropes should never be left where humidity or temperatures are too high, since this will cause them to dry out. When stored, ropes should be cleaned and hung up where they can dry. Too much moisture will cause a fiber rope to rot.

Wire rope is better than fiber rope for heavy-duty work for the following reasons:

- Wire rope is stronger and more lasting than a fiber rope with the same width and weight.
- Wire rope has the same strength, whether wet or dry.
- Wire rope will not shrink or stretch under changing weather conditions.

A wire rope is made up of several strands of separate wires and a core. A major cause of stress and wear of a wire rope is shock load. Shock load is caused when a load is put on a slack rope suddenly. This sudden shock will put too much stress on the rope even when the load is one that would not normally be too heavy for the rope.

Shock load is also caused by quickly speeding up or slowing down a load being lifted.

A shock load does not always break a rope immediately. It may only weaken the rope, causing it to break later with an operator who does not realize that it has been overstressed.

Shock loads can be avoided by (1) making sure there is no slack and no jerking of the sling at the start of the loading, (2) checking loads to make sure that they do not weigh more than the rope's limit, and (3) putting on speed slowly and smoothly.

Other causes and signs of wear of a wire rope are listed here:

- Dragging the rope over the ground, which causes dirt to work its way between the strands, causing internal wear.
- Kinking, which is caused by lifting when the rope is not straightened out or when there is a slack in the rope. (This leaves a weak place even after kinks are removed.)
- Reverse bends — bending rope in one direction and then in another will cause it to wear out quickly.
- Cross winding — rope is wound around the drum in several layers. (The drum should be large enough to take all the rope in a single layer.)
- Lack of lubrication — regular lubrication, with a lubricant made especially for use on wire rope, will prevent rusting and keep rope pliable.

The worker must watch for signs of weakness in a wire rope and report any such signs to the supervisor, but the regular inspection and maintenance should be done by a mechanic who has been specially trained.

ACTIVITY 13:

Name four causes of wire rope wearing out.

1. _____
2. _____
3. _____
4. _____

OBJECTIVE 14: Name three kinds of damage that should be checked for during a chain sling inspection.

Slings are used in many material-handling operations to lift loads. Because they are under a great deal of stress, they should be inspected by a qualified person both before and during use. Workers also need to know how much slings can lift and signs of damage to watch for in slings.

Slings should always be used within the safe working load limit. This information, along with the manufacturer's name and the sling composition, should be marked on each sling.

Because many factors multiply load weights, the rope must be capable of handling five times the weight actually involved. When the angles of the sling legs (the rope actually connected to the load) are increased, the stress on the rope grows dramatically. (For example, a 1000-pound load can create the stress of a 1932-pound load if the ropes are attached to a 75 degree angle as in Figure 14.)

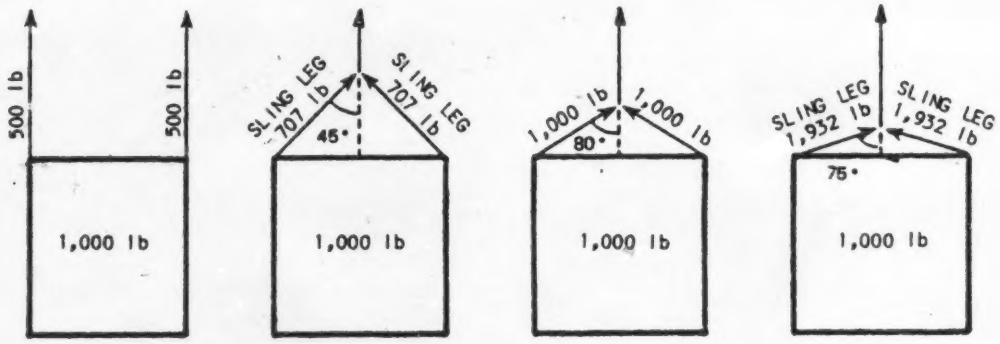


Figure 14. The stress on the sling becomes greater as the angle between the sling legs increases.

Slings are most often damaged at the point where the load puts pressure on the slings. The worker should watch for frayed fibers or broken wires at these areas.

When loads have sharp edges that could cut through a sling, pads should be used around the sharp corners or edges of the load. Slings are made of either fiber rope, wire rope, or chains. Chain slings, made of alloy steel,

are better than fiber or wire slings for lifting in very high temperatures. In these circumstances, the working load of the chain sling must be lessened. For example, a chain that can carry 4000 pounds, will only be able to carry 2000 pounds if it is used where the temperature reaches 1000 degrees. Even after it cools from this temperature, it will be able to carry only 3400 pounds safely. The safe load limit is permanently reduced by the high temperatures.

As with rope slings, chain slings are subject to extra stress because of faulty hitches, slipping, bumping, and the angle of attachment to the load.

Chain slings should be checked for three kinds of damage: stretch, wear, and nicks or gouges.

Damage to a chain sling from stretch is always due to overloading. To check for stretch, the worker must measure the chain from the bearing point on the load attachment. If the length of the chain has increased by three percent or more from its recorded size (which appears on the sling), the sling should be removed from service.

Wear on the bearing points of the links or in the inside ends can be checked by pushing the links together until the inside surface shows.

Wear also occurs on the outside of the links when the chain is dragged along rough surfaces or pulled out from under heavy loads.

How serious nicks and gouges are depends on where they are on the links. The danger areas are on the inside part and outside ends of the links.

A worker should not try to make repairs to a chain sling. Damage to the sling should be reported to the supervisor and the sling thrown out.

ACTIVITY 14:

Name three kinds of damage that should be checked for during a chain sling inspection.

1. _____
2. _____
3. _____

List two procedures to be followed if a chain sling shows signs of deterioration or damage.

1. _____
2. _____

OBJECTIVE 15: Name three precautions that must be taken to prevent a rope, load attachment, or mechanism of a crane from breaking, releasing a load in midair, and injuring a worker.

A crane is a lifting machine with a power-operated, inclined boom and lifting tackle. The cab houses the power unit and controls.

In most plants, the maintenance department does regular inspection and maintenance of cranes. But this does relieve the operator from the responsibility of checking equipment daily and reporting any faults promptly. If a hazard is suspected, the crane should not be used.

The crane operator should report any of the following defects:

- Deformed, cracked, or corroded parts.
- Loose belts or rivets.
- Broken strands on hoist cables.
- Failure of load limit switches.
- Noisy gears.
- Mechanical parts loosened by vibration.

Maintenance programs based on manufacturer's suggestions should be set up by the employer. Before any maintenance work begins, the crane should be moved to an area away from other operations. Controls should be at the OFF position. The main or emergency switch should be open and locked in the open position so the crane cannot be started. Signs giving warning that the machine is out of order must be posted. When maintenance work has ended, the machine should not be put back in service until guards have been replaced, safety devices started again, and maintenance equipment removed from the crane.

Working with cranes presents some serious dangers. For example, a rope, load attachment, or mechanism may break, releasing a load in midair, causing injury to a worker below.

To guard against this type of accident, the operator must never carry a suspended load over any persons, must make sure that all workers are clear of the load before moving it, and must never load a crane beyond its posted capacity.

Another type of accident that occurs with the use of cranes is where a worker is caught between moving parts of the equipment. Guards placed around the gears and other moving parts of the crane will prevent this from happening. Guards also should be placed at common pinch points for hands, where running ropes pass over sheaves in the load block. Guards at these points will also prevent tangling when the block is lying on the ground with the ropes loose.

A very serious danger in the operation of mobile cranes is the possibility of striking power lines. If a mobile crane must pass under a power line often, it is best to have a crossarm guard, such as the one shown in Figure 15, built on both sides of the power line. The crossarm should be at least six feet below the wires with the supports far enough apart to let the crane pass through easily.

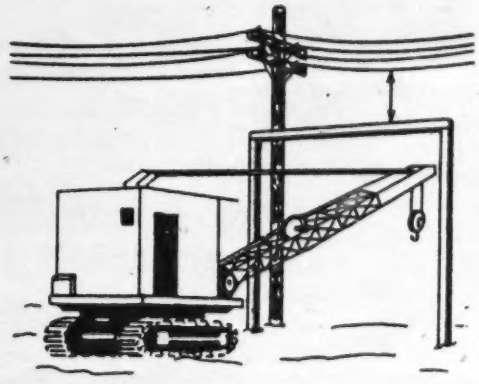


Figure 15. Crane with crossarm.

Only a qualified and assigned operator should run a crane. This worker should take signals from no one other than the hook-on worker, who often serves as the operator's eyes. For this reason, both the operator and hook-on person must know the standard hand signals for crane operators, as shown in Figure 16. The signals are used in place of spoken signals that would not be heard in a noisy place.

The hook-on person must be skilled in handling, setting, and stacking all types of materials. The hooks must be centered over the load to keep the load from swinging, a situation which would add strain to the rope and hoisting mechanism or could strike a worker.

The load must not be moved until the operator has been given and understood the signal from the floor. If there are several hook-on workers, only one should have the authority to signal, so operators will not be confused. Operators should make sure that hook-on workers are clear before the load

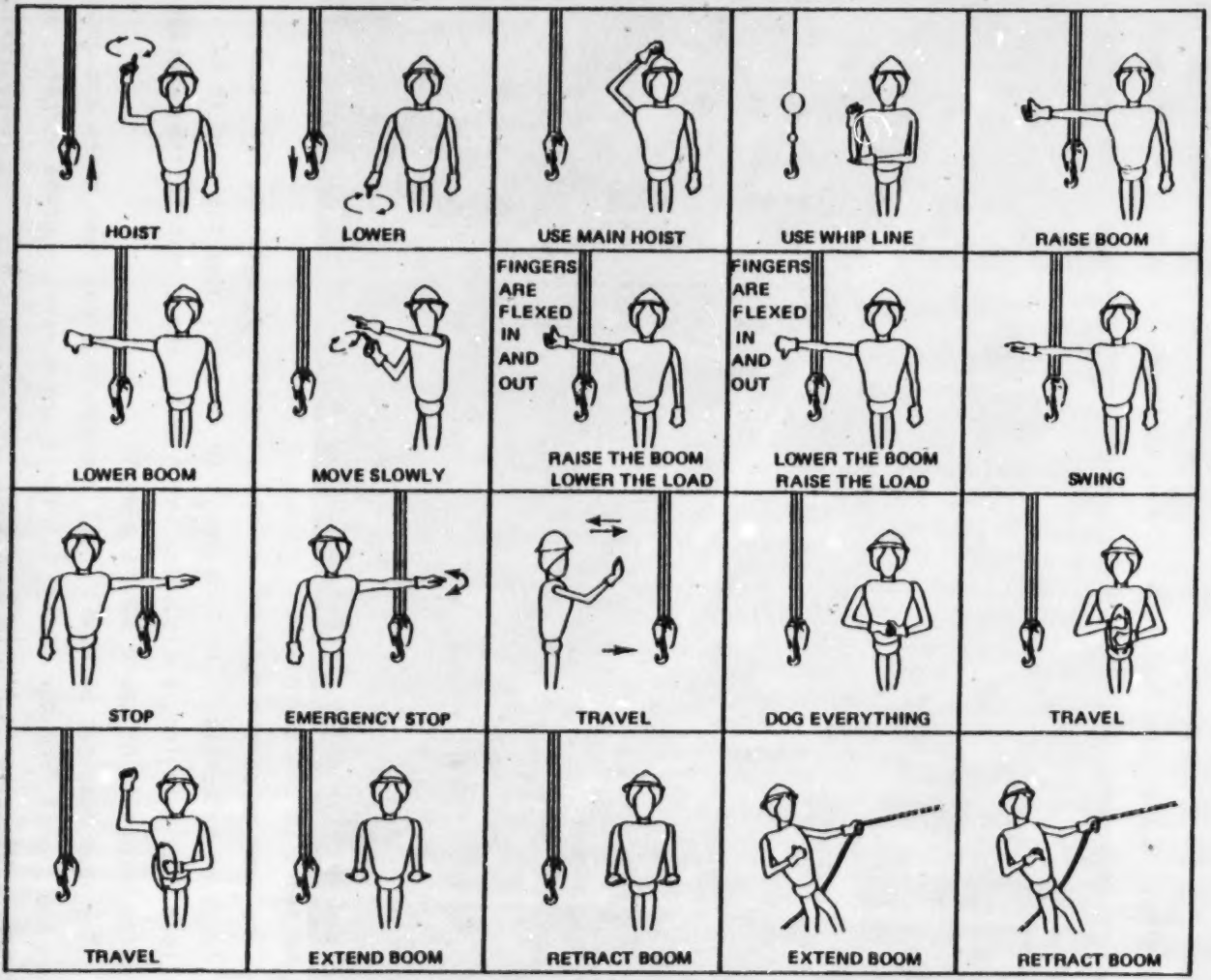


Figure 16. Standard signals used in operating power cranes and shovels.

is lifted. The operator should note the location of all nearby stockpiles, machinery, and structures and make sure the crane or its load will not run into any of these. Operators must never leave a load hanging, and a warning signal should be given when the load goes near a person.

The hoist chain or rope on the crane should be kept in good condition following the standards for rope and chain slings already mentioned.

ACTIVITY 15:

Name three precautions that must be taken to prevent a rope, load attachment, or mechanism of a crane from breaking, releasing a load in midair, and injuring workers.

1. _____
2. _____
3. _____

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ANSWERS TO ACTIVITIES

ACTIVITY 1

1. Position feet near load.
2. Keep back straight, squat close to load.
3. Grasp load at diagonally-opposite corners.
4. Tuck in chin.
5. Lift with legs.
6. Do not jerk or twist.

ACTIVITY 2

1. Bars – (Any of the following)
   a. Pinch points can jam fingers, etc.
   b. Cracks or weak points could mean bar breaks and load is dropped.
   c. Grease or other slippery substance on hands could cause bar to slip and load to be dropped.
2. Hooks – (Any of the following)
   a. Dull hooks can slip.
   b. Hook handles can be splintered.
   c. If hook is carried on belt, point could catch on someone or something and injury result.
3. Rollers – (Any of the following)
   a. Using makeshift rollers is dangerous, since they could become deadly missiles.
   b. Feet can be crushed by rollers.
4. Jacks – (Any of the following)
   a. Jacks can break if load limit is exceeded.
   b. If not placed on level surface, they can sink and tip the load off-balance.
   c. Load can tip and crush feet or legs.

5. Shovels — (Any of the following)
   a. Splintered handle can injure hands.
   b. Foot can be injured if force is applied to shovel wrongly.
   c. Shoes with inadequate soles can lead to injury with shovels.

ACTIVITY 3

1. Hand truck can roll or fall off dock plate or platform.
2. Collision with another object.
3. Worker's hands are jammed against door frames or other obstructions.

and

1. Knuckle guard.
2. Brakes.

ACTIVITY 4

Behind the truck.

ACTIVITY 5

1. They move faster.
2. They are harder to stop.

ACTIVITY 6

1. Obstacle evasion.
2. Backing techniques.
3. Inspecting vehicles.
4. Positioning forks in loading and carrying materials.

ACTIVITY 7

1. Electrically-powered trucks present dangers from contact with acids and fire hazards.
2. Fuel-powered trucks (diesel, gasoline, or liquefied petroleum gas) present danger from fire and explosion.

ACTIVITY 8

1. Correct.
2. Incorrect.
3. Correct.
4. Incorrect.
5. Correct.

ACTIVITY 9

To provide a smooth, gapless, riding surface between a vehicle and dock. Check to see that the dock plate is fastened securely, and that it is heavy enough to bear the weight of the lift truck and its load.

ACTIVITY 10

1. Set brakes.
2. Block rear wheels with chocks.

ACTIVITY 11

1. Use a dock plate wide enough to allow trucks to enter at a safe angle.
2. Anchor dock plate securely.
3. Rail cars to be loaded or unloaded must be marked by flags or lights.
4. No other car or engine should be coupled to a car while it is being unloaded.

ACTIVITY 12

1. A powered, portable-belt conveyor.
2. Vibrating conveyor.
3. Overhead conveyor.

and

1. Getting caught in the nip point.
2. Getting caught in a piece of material on the conveyor.

ACTIVITY 13

Any four of the following:

Shock load.

Dragging the rope over the ground.

Kinking.

Reverse bends.

Cross winding.

Lack of lubrication.

ACTIVITY 14

1. Stretch.
2. Wear.
3. Nicks or gouges.

and

1. Damage should be reported to supervisor.
2. Sling should be thrown out.

ACTIVITY 15

1. Never carry a suspended load over any persons.
2. Make sure all workers are clear of the load.
3. Avoid overloading the crane.